WSDOT MITIGATION SITES
SOUTH CENTRAL REGION

2004 MONITORING REPORT

Wetland Assessment and Monitoring Program

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South Central Region 2004 Annual Monitoring Report

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Executive Summary

This report documents the status of the South Central Region mitigation sites (Map 1) with respect to performance criteria for 2004. The following tables summarize success standards and results obtained in 2004.

Site Name	Performance Criteria	2004 Results[1]
I-90 Tinkham Road (Year 1 of 3)		
	100% survival of all planted species	100% survival (total count)
SR 970 Teanaway River Bridge (Year 5 of 5)		
	$\geq$ 1.70 stems/m^2 on the site	1.07 stems/m^2 ($CI_{80\%}$ = 1.05-1.09 stems/m^2)
	Control non-native invasive plants	15% aerial cover (qualitative)
SR 12 Naches River (Year 5 of 5)		
	50% aerial cover by woody species	48% ($CI_{80\%}$ = 41 – 55% cover)
	$\geq$80% aerial cover in the emergent area, with 60% aerial cover of native species	70% ($CI_{80\%}$ = 63 – 82% cover) 99% relative cover by native species
SR 97 Toppenish (Year 1 of 5)		
	Less than 10% invasive species	75% ($CI_{90\%}$ = 67-84%)
SR 823 Selah (Year 7 of 8)		
	$\geq$ 50% woody cover in forested wetland, at least 3 species	Macroplot 1: 20% aerial cover[2] Macroplot 2: < 5% aerial cover
	$\leq$ 10% non-native species	Macroplot 1: 4% ($CI_{80\%}$ = 3%-5%) Macroplot 2: 5% ($CI_{80\%}$ = 4%-7%)

[1] Estimated values are presented with their corresponding statistical confidence interval. For example, 48% ($CI_{80\%}$ = 63-82% aerial cover) means we are 80% confident that the true aerial cover value is between 63% and 82%.
[2] The site is divided into two sections by a preservation area. Macroplots were used in each section to facilitate data collection.

List of Acronyms

Acronym	Meaning
CI	Confidence Interval (see Methods and Glossary)
FAC	Facultative Indicator Status (see Glossary and Reed 1988)
FACW	Facultative Wetland Indicator Status (see Glossary and Reed 1988)
IP	Individual Permit
MP	Mile Post
NWP	Nationwide Permit
OBL	Obligate Wetland Indicator Status (see Glossary and Reed 1988)
SR	State Route
USACE	United States Army Corps of Engineers
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

Introduction

Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) evaluates the potential for degradation of critical areas that may result from these infrastructure improvements. WSDOT complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 89-10). Generally, mitigation sites are planned when transportation improvement projects have unavoidable effects to critical and/or sensitive areas. The WSDOT Wetland Assessment and Monitoring Program monitors these mitigation sites as a means of evaluating compliance with permit conditions and tracking site development and performance. This report documents the status of the South Central Region mitigation sites with respect to their performance and success standards for 2004 (Map 1).

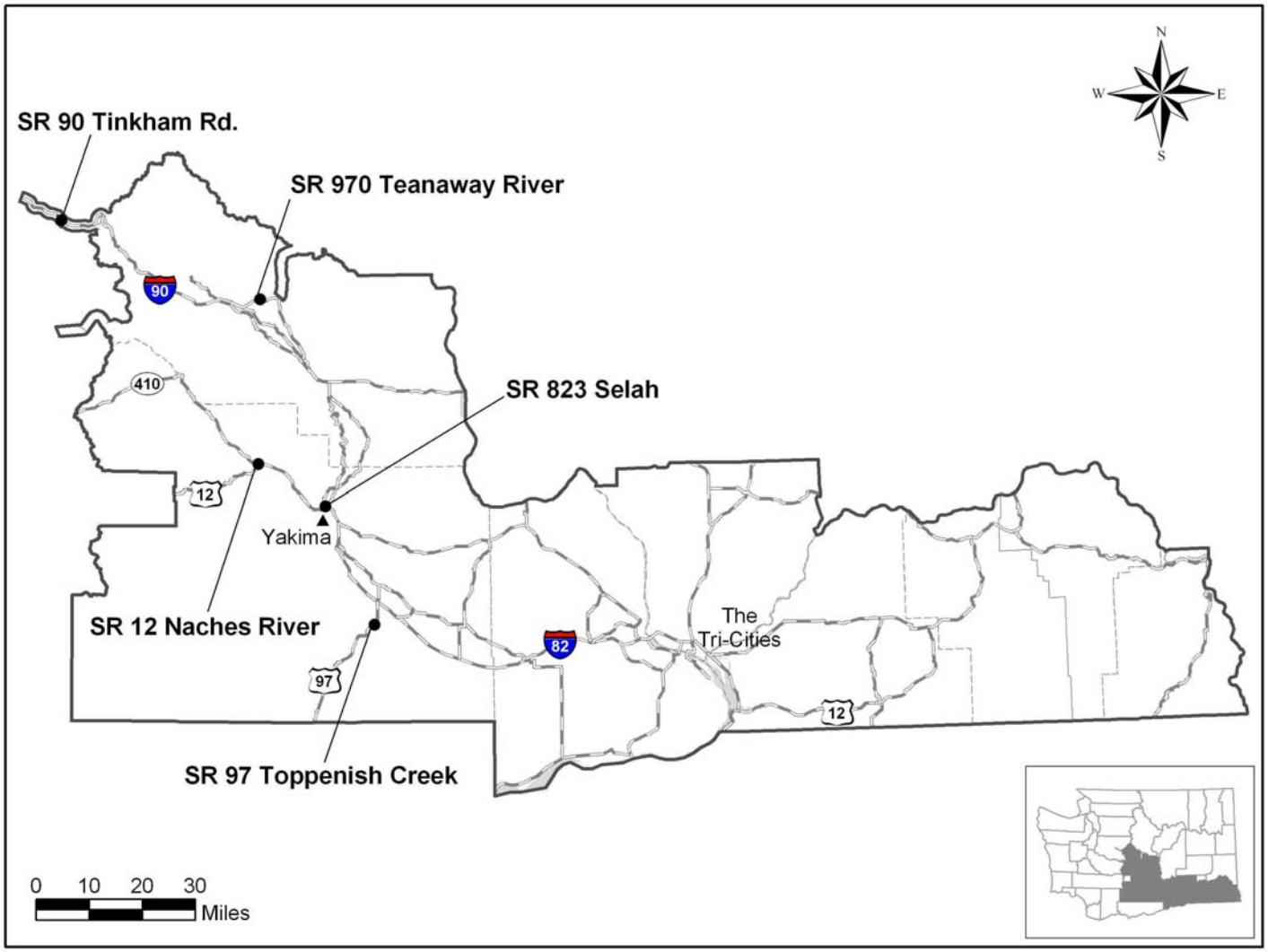
Process

Monitoring typically begins the first spring after a site is planted and continues for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years. In special cases sites may be monitored beyond the designated monitoring period.

Monitoring activities are driven by site-specific performance and success standards detailed in the mitigation plan or permits. Data are collected on a variety of environmental parameters including vegetation, soils, hydrology, and wildlife. When data analysis is complete, information on site development is communicated to region staff to facilitate management activities as part of an adaptive management process. Monitoring reports are submitted to regulatory agencies and published on the web at:

http://www.wsdot.wa.gov/environment/wetmon/MonitorRpts.htm

Map 1 South Central Region Mitigation Site Locations



Methods

Methods used for monitoring mitigation sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.[3] The Wetland Program's current monitoring methods include the following key elements:

Objective-based Monitoring

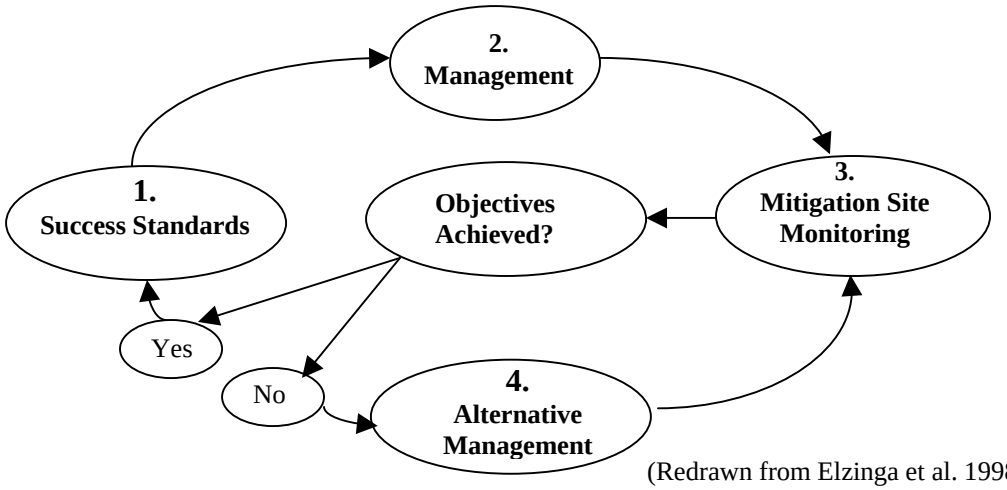
We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, permit requirements, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process includes four iterative steps:

1. success standards are developed to describe the desired condition,
2. management action is carried out to meet the success standard,
3. the response of the resource is monitored to determine if the success standard has been met, and
4. management is adapted if the standards are not achieved.

Monitoring is integral to the success of an effective adaptive management strategy. Without valid monitoring data, management actions may or may not result in improved conditions or compliance with regulatory permits. Timely decisions, based on valid monitoring data, result in increased efficiency and higher probabilities of success (Shabman 1995; Thom and Wellman 1996). The adaptive management process is illustrated in Figure 1.1.



(Redrawn from Elzinga et al. 1998)

Figure 1.1 The Adaptive Management Process

[3] These methods are based on techniques described in Bonham (1989), Elzinga et al. (1998), Krebs (1999), Zar (1999), and other sources.

Data Collection and Analysis

WSDOT's monitoring approach strives to minimize subjectivity in data collection and increase the reliability of data collection and analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, interspersion and independence of sample units, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

Success Standards and Sampling Objectives

Success standards (or performance standards) are important elements of a mitigation plan. They indicate the desired state or condition of the mitigation site at a given point in time. Conditional permit requirements, if different from success standards in the mitigation plan, are also evaluated during monitoring activities. Some mitigation plans also provide contingencies if a specific undesirable condition occurs. Contingencies typically initiate a management response at the onset of a particular condition, for example, excessive cover by invasive species or insufficient cover by trees and shrubs.

Wetland Assessment and Monitoring program staff thoroughly examine success standards and permit requirements to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in the mitigation plan or permit, clarification is sought from region staff.

Success standards are copied verbatim from the mitigation plan in the success standards and sampling objectives section of each site report. Differences in common usage of the terms *aerial* and *areal* has made their interpretation in mitigation plans difficult.[4] The Glossary defines the meaning of these words as used in this document.

Sampling may be required to address success standards unless an efficient and reliable total accounting of the target attribute can be conducted. Sampling objectives are developed to guide the data collection process. Sampling objectives include a confidence level and confidence interval half width.

The results of sampling are presented with the confidence level and confidence interval noted as ($CI_X = Y_1$-Y_2), where CI = confidence interval, X = confidence level, and confidence interval width is expressed as Y_1 low estimate to Y_2 high estimate. For example, an estimated aerial cover provided by woody species reported as 65% ($CI_{80\%}$ = 52-78% aerial cover) means that we are 80% confident that the true aerial cover value is between 52% and 78% (Figure 1.2).

[4] We feel that the term aerial better describes the intent of the mitigation plans in most cases. Where we judge the word *areal* has been used arbitrarily in the success standards, we follow it with a (*sic*) notation.

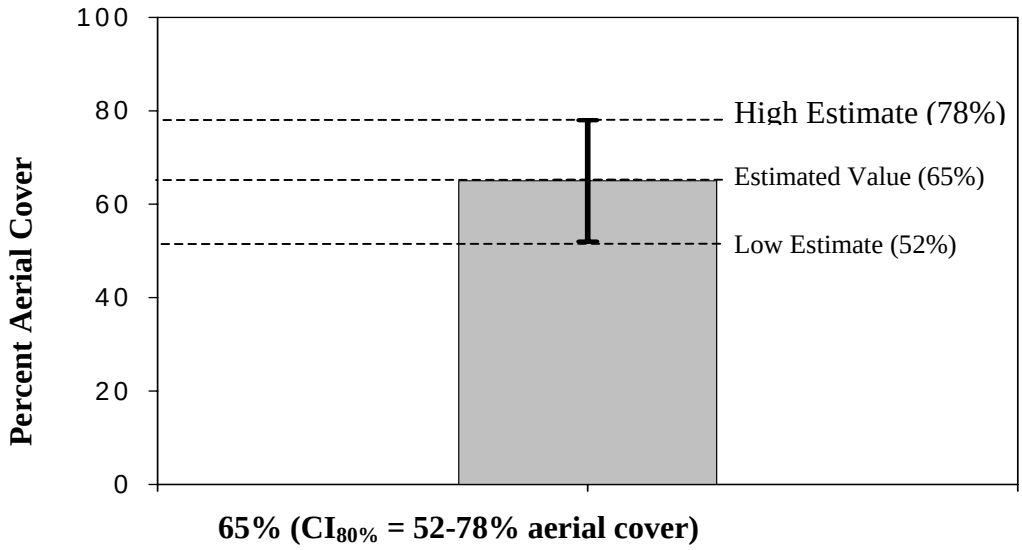


Figure 1.2 Estimated Cover Value Expressed with Confidence Interval Range

For compliance purposes, aerial cover calculations include only areas covered by rooted vascular plants (including floating-leaved species). Areas covered by thallophytes (algae, fungi, bacteria), bryophytes (mosses and liverworts), structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, most common names, and nativity used in this report were obtained from the *PLANTS Database* (USDA 2003 (http://plants.usda.gov)). Hydrophytic plant indicator status was obtained from the *National List of Plant Species that Occur in Wetlands: Northwest* (Reed 1988 and 1993). Where noxious weeds are addressed, county specific listings in the *State Noxious Weed List* are referenced (Washington State Noxious Weed Control Board 2003 www.nwcb.wa.gov).[5]

Sampling Design

When sampling is required, a sampling design is developed for the site or zone of interest. Sampling designs can vary from simple to complex depending on the number and type of attributes to be measured. Specific elements such as the size and shape of the site, the presence of environmental gradients, plant distribution patterns, and the amount of time and resources available for monitoring are factors that influence the sampling design. Additional elements typically include the location of the baseline, orientating transects parallel to the primary environmental gradient (Figure 1.3), the method of data collection, and the number and type of sample units to be used. Depending on the sampling objective and site characteristics, transects may vary in number, length, and separation distance. Sampling transect locations are determined by using either a simple, systematic, stratified, or restricted random sampling method.

[5] In some cases, other nuisance species may be included in invasive cover estimates.

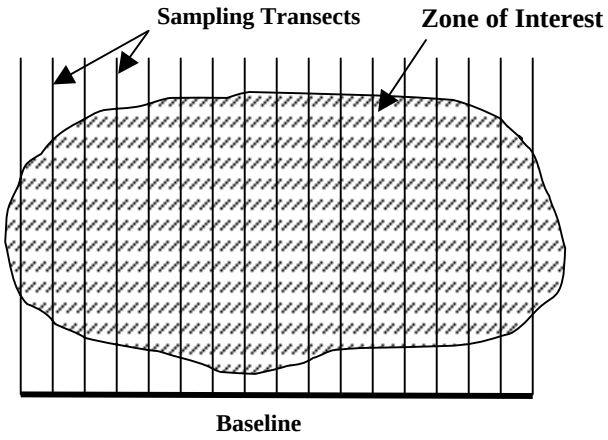


Figure 1.3 Baseline and Sampling Transects

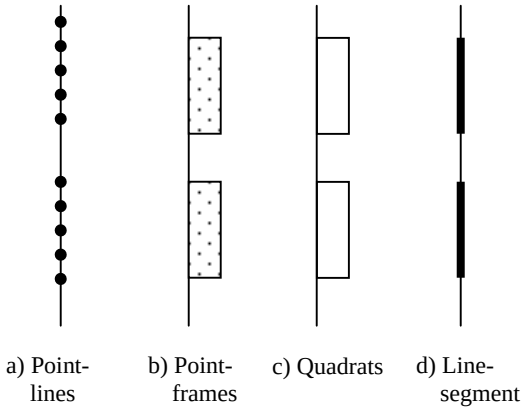


Figure 1.4 (a-d) Sampling Transects and Sample Units

A diagram showing the sampling design is typically included in mitigation site reports. Sample units appropriate to one or more of the methods described below are randomly located on or adjacent to the sampling transects (Figure 1.4 a-d). These figures are general representations of the actual sampling designs and do not include specific details. Typically, point-lines and point-frames are used to collect herbaceous cover data, quadrats are used to estimate survival and density, and line-segments are used to estimate woody cover.

Point-Line Method

To estimate cover by herbaceous and/or woody species, sample units consisting of a fixed set of points (point-lines) are randomly located along sampling transects (Bonham 1989; Elzinga et al.1998) (Figure 1.4a). Tools used to collect point-line data include point-intercept devices, pin flags, or densitometers. These tools are used to identify point locations. Target vegetation intercepted by the point locator is recorded. If target species are not encountered on the point; bare soil, non-vascular plant, or habitat structure is recorded as appropriate. For each sample unit, cover is determined based on the number of times target vegetation is encountered divided by the total number of points. For example, if invasive species were encountered on 20 points from a sample unit composed of 100 points, the aerial cover of invasive species for that sample unit is 20 percent.

Point-Frame Method

To estimate cover by herbaceous species, point-frames are randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). A point-frame is a rectangular frame that encloses a set of points collectively serving as a sample unit (Figure 1.4b).[6] The point frame is lowered over herbaceous vegetation and data is recorded where target vegetation intercepts point locations. As with the point-line method, a cover value for each sample unit is determined. For example, if facultative-wetland (FACW) and obligate (OBL) species were encountered on 20 points in a point-frame composed of 40 points, the aerial cover of FACW and OBL species for that point-frame sample unit is 50 percent.

[6] The WSDOT Wetland Assessment and Monitoring Program typically uses a frame formed with polyvinyl chloride (PVC) pipe. Strings span the frame lengthwise and points are marked on the strings using a standard randomization method.

Quadrat Method

To estimate survival or density of woody species in an area, quadrat sample units are randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). Quadrat width and length are based on characteristics of the target plant community and its pattern of distribution. Quadrats are typically located lengthwise along sampling transects (Figure 1.4c). Target plants within a quadrat are recorded as alive, stressed or dead. The success standard or contingency threshold can be addressed with a percent survival estimate of plantings, or a density per unit area of living plantings as appropriate. For example, if eight planted woody species were recorded as alive and two were recorded as dead in a sample unit measuring 1 x 20 meters, the survival of planted woody species for that sample unit would be 80 percent, and the density would be 0.4 live plants per square meter.

Line-Intercept Method

To estimate aerial cover by woody species, line-segment sample units (Bonham 1989; Elzinga et al.1998) are randomly located along sampling transects (Figure 1.4d).[7] The length of woody vegetation canopy intercepting each sample unit length is recorded. To calculate the aerial cover for each sample unit, sum the canopy intercepts and divide by the sample unit length. For example, if woody vegetation was encountered on 80 meters of a 100-meter sample unit, the aerial cover for that sample unit is 80 percent.

Sample Size Analysis

With each of the above methods, sample size analysis is performed in the field to ensure that an adequate number of sample units are obtained to report the data at the specified confidence level and interval. The mean percent aerial cover value and standard deviation are calculated from the data, and sample size analysis is conducted. For data reported in this document, the following sample size equation for estimating a single population mean or a population total within a specified level of precision was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[8]
n = unadjusted sample size

A sample size correction to n is necessary for adjusting "point-in-time" parameter estimates.[9] The adjusted n value identifies the number of sample units required to report the estimated mean value at a specified level of confidence.

Unequal-Area Belt Transect Method

For surveys of irregularly shaped regions, the unequal-area belt transect method provides a sampling protocol that may be particularly useful for assessments of woody species density or survival (Stehman and Salzer 2000). With this technique, fixed-width belt transects (quadrats) are positioned perpendicular to a baseline using a simple, systematic, or restricted random

[7] Depending on site conditions and other considerations, woody cover data may be collected using the point-line method and a densitometer.

[8] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

[9] Adjusted n values found in this report were obtained using the algorithm for a one-sample tolerance probability of 0.90 (Kupper and Hafner 1989; Elzinga et al 1998).

sampling method. Once a belt transect has been located, field crews traverse the entire length of the transect counting all plants within its perimeter.

The following equations are used to analyze plant density data collected from unequal-area belt transects.

First, density is estimated using a ratio estimator of the mean number of plants per transect divided by the mean area per transect.

$$\hat{D} = \frac{\bar{y}}{\bar{a}}$$

$\hat{D}$ = sample-based estimator of density
$\bar{y}$ = sample mean plants per transect
$\bar{a}$ = sample mean transect area

Second, variance of the sample-based density estimator is derived from the following equation.

$$\hat{V}(\hat{D}) = \frac{1}{\bar{a}^2}\left(\frac{N-n}{N}\right)\frac{s_e^2}{n}$$

N = population size
n = sample size
s_e^2 = pooled variance[10]
$\hat{V}(\hat{D})$ = variance of the density

Finally, a confidence interval for the sample-based estimator is calculated as follows.

$$\hat{D} \pm (t)[SE(\hat{D})]$$

$\hat{D}$ = sample-based estimator of density
SE = sample standard error

For more information on the unequal-area belt transect method and data analysis techniques see Stehman and Salzer (2000).

Wildlife Monitoring

Many mitigation plans include goals and objectives that address wildlife. For these sites, incidental wildlife observations are obtained to provide information to support the results of the vegetation monitoring.

Some success standards contain more specific reference to monitoring the avian community. These sites receive three bird surveys conducted during the breeding season (April through mid-July). The point count method (Ralph et al. 1993) is used to document species richness and relative abundance.

Species diversity indices (H) may be calculated from bird survey data using the Shannon-Wiener function (Krebs 1999). Results are expressed as a mean annual species diversity index.

[10] $s_e^2 = \sum_s \left(y_u - \hat{D}a_u\right)^2 \Big/ (n-1)$

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to *i*th species

The following *t* test is used to test the null hypothesis that diversity indices from different years are equal (Zar 1999).

$$t = \frac{H'_1 - H'_2}{S_{H'_1 - H'_2}}$$

H' = index of species diversity
$S_{H'_1 - H'_2}$ = standard error of the difference between species diversity indices H'_1 and H'_2

Hydrology Monitoring

Primary and secondary field indicators of wetland hydrology (Ecology 1997) are recorded to address hydrology standards and to aid in future delineation efforts. Wetland mitigation sites are delineated in the spring following the last year of vegetation monitoring so the actual wetland area can be compared to the planned wetland area.

Literature Cited

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King County

I-90 Tinkham Road USACE NWP 2002-4-00873

Photo 2.1 **View of the I-90 Tinkham Road mitigation site from I-90 looking south.**

I-90 Tinkham Road USACE NWP 2002-4-00873

This report summarizes management and monitoring activities completed by the Washington State Department of Transportation (WSDOT) at the I-90 Tinkham Road mitigation site from Fall 2003 through Fall 2004. WSDOT Wetland Monitoring and Assessment Program activities were intended to address success standards for 2004. These activities include vegetation survival surveys and photo-documentation. Table 2.1 provides general site information and Table 2.2 summarizes this year's monitoring results.

Table 2.1 General Information for the I-90 Tinkham Road Mitigation Site

USACE NWP 13 Number	2002-4-00873
WDFW HPA Permit Number	ST-F5337-02
King Co. DDES Grading Permit Number	LO2CG229
Township/Range/Section (impact)	T.22N/R.10E/S.06
Mitigation Location	Tinkham Rd. access to east bound I-90 at MP 42.5, King Co.
Construction dates	2003-2004
Monitoring Period	2004 to 2006 or until standards are met
Year of Monitoring	1 of 3
Type of Mitigation	Slope stabilization

Table 2.2 2004 Monitoring and Management Summary for SR 90 Tinkham Road Mitigation Site

Performance Criteria	2004 Results	Management Activities
Success Standard		
100% survival of all planted species	100% survival (total count)	Weed control, replanting

Success Standard

The first-year success standard for the I-90 Tinkham Road mitigation site was excerpted from the *Mitigation and Revegetation Plan For I-90 MP 42 Slope Stabilization Project* (Morin 2003). Appendix 2.1 provides the complete text of the success standards, Appendix 2.2 provides additional permit requirements, and Appendix 2.3 shows the planting plan and photo point locations (Morin 2003).

Success Standard 1
100% survival, all failed plants will be replaced. "Year one" will begin at the completion of both phases of the project (2004).

Permit Requirement
In year 1 after plant installation, a short memo report shall be submitted to document the successful implementation of the planting plan.

Methods

To address plant survival (Success Standard 1), each planting was identified to species and recorded as alive or dead. Empty planting wells were recorded as dead unknowns.

Photos were obtained from established photo points as required by the mitigation plan (Morin 2003).

Results and Discussion

Success Standard 1 – Survival of Planted Species

Plant installation was completed in May 2004 followed by irrigation during the summer months. In August, a total count was conducted showing that 100 percent survival had not been achieved. In October 2004 replacement plants were installed. This brings the site into compliance with Success Standard 1. Table 2.3 shows survival and replanting data by species.

Table 2.3 2004 Survival of Planted Vegetation at SR 90 Tinkham Road Mitigation Site

Scientific Name **(Common Name)**	**Initial Plantings**	**Live Plants in August 2004**	**After Re-planting in October 2004**
Acer circinatum (vine maple)	125	88	138
Cornus sericea (redosier dogwood)	125	84	159
Physocarpus capitatus (Pacific ninebark)	100	61	61
Populus balsamifera (black cottonwood)	70	54	129
Rosa pisocarpa (cluster rose)	125	74	124
Rubus spectabilis (salmonberry)	50	42	42
Salix species (willows)	100	125	175
Thuja plicata (western red cedar)	70	13	43
Total	**765**	**541**	**871**

The SR 90 Tinkham Road revegetation project is meeting the first-year success standard. Establishment of herbaceous and woody vegetation on-site contributes to the reduction of bank erosion. With continued growth of this vegetation the potential of providing wildlife habitat and shade will increase.

Management Activities

Weed control was conducted in August 2004. Invasive species were qualitatively estimated to provide 1-2% cover on the site, and do not presently pose a threat to successful site development.

Appendix 2.1 – I-90 Tinkham Road Standards of Success

The following excerpt is from the *Mitigation and Revegetation Plan For 1-90 MP. 42 Slope Stabilization Project* (Morin 2003). The standards addressed this year are identified in **bold** font.

Revegetation / Mitigation
The goal of the revegetation in the project vicinity is to develop a viable vegetation matrix that aids in re-establishing banks and improving the ecological functionality. The species listed below (p. 19) were chosen due to their adaptation to the riparian environment, ease of establishment, root mass, rate of growth and habitat value. This vegetation matrix is an important component in strengthening the embankment, reducing erosion and providing shade and wildlife habitat.

Performance Standards
Vegetative performance standards are based on King County DDES standards, modified for the site location. Typically the standard calls for 85% survival and 60% cover in the third year. Due to elevation and resultant temperatures and length of growing season these figures have been adjusted to meet the following standards.

- **Year one- 100% survival, all failed plants will be replaced. "Year one" will begin at the completion of both phases of the project.**
- Year three- 80% survival, >50% cover

Monitoring/Site Maintenance – WSDOT recognizes and accepts the responsibility of regular monitoring and site maintenance. Quantitative monitoring will occur in the early summer of the first year to ensure the "year one – 100% survival" standard. This will consist of a simple stem count followed by replacement of all failed plantings. The site will be monitored by qualitative analysis and documented with regular photographs on an annual basis. **Photographs will be taken in July of each year from established photograph points. A yearly status report including pertinent photographs, management activities and site conditions will be submitted to King Co. by December each year until the third year or until the performance standards are met.**

Contingencies – If there is a significant problem with the mitigation achieving its performance standards, the WSDOT shall work with King County to develop a Contingency Plan. The contingency plan would include, but are not limited to: regarding, additional plant installation, erosion control, modifications to hydrology, and plant substitutions of type, size, quantity, and location. Such Contingency Plan shall be submitted to County by December 31 of any year when deficiencies are discovered.

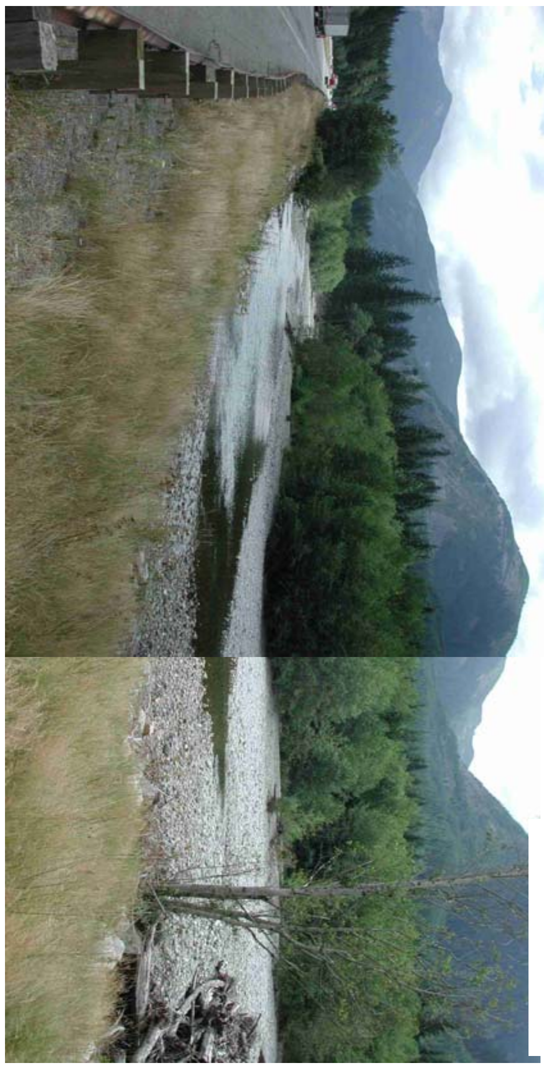
Planted species (trees 9 feet OC, shrubs 5 feet OC):

Redtop	*Populus balsamifera* (black cottonwood)
Molate Red Fescue	*Alnus rubra* (red alder)
Mountain Brome	*Thuja plicata* (western red cedar)
Blue Wild Rye	*Cornus sericea* (redosier dogwood)
Tufted Hairgrass	*Salix scouleriana* (Scouler's willow)
	Acer circinatum (vine maple)
	Physocarpus capitatus (Pacific ninebark)
	Rubus spectabilis (salmonberry)
	Rosa pisocarpa (cluster rose)

Established Photo Points

Photo Station #1

East



South

3 August, 2004

Photo Station #2

East

West

3 August, 2004

Photo Station #3

South

West

3 August, 2004

Photo Station #4

3 August, 2004

Photo Station #5

3 August, 2004

Appendix 2.2 – I-90 Tinkham Road Additional Permit Requirements

The following excerpt is from the *King County Department of Development and Environmental Services Grading Permit*. The section of the permit that pertains this year is identified in **bold** font.

Special Condition 5550-
To ensure survival of plant material and control of non-native plant species, the permittee shall monitor the site for a period of five years. At the end of five years, 80% of the vegetation planted for mitigation must survive and non-native species shall comprise no more than 5% cover in the mitigation areas. The 80% survival shall be evaluated by strata rather than by species. (i.e., 80% survival of all native trees planted, 80% of all shrubs planted, 80% of all ground cover planted). Native species that have established within the mitigation areas on their own may be included in the monitoring. The permittee shall submit monitoring status reports on years 3 and 5 after installation of the plants. **In year 1 after plant installation, a short memo report shall be submitted to document the successful implementation of the planting plan.** Plant mortality exceeding 20% after 5 years will be addressed with replacement of plant species lost, or with other appropriate native species with KCDDES concurrence.

Appendix 2.3- I-90 Tinkham Road Planting Plan

(Morin 2003)

Literature Cited

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Kittitas County

SR 970 Teanaway River Bridge USACE IP 97-4-01124

Photo 3.1 **View of the SR 970 Teanaway River Bridge mitigation site along the bank of the Teanaway River.**

SR 970 Teanaway River Bridge USACE IP 97-4-01124

This report summarizes management and monitoring activities completed by the Washington State Department of Transportation (WSDOT) at the SR 970 Teanaway River Bridge mitigation site from September 2003 to December 2004 (Photo 3.1). WSDOT Wetland Monitoring and Assessment Program activities were intended to address permit requirements for 2004. These activities include vegetation surveys for plant density and invasive species cover. Table 3.1 provides general site information and Tables 3.2 summarizes this year's monitoring results.

Table 3.1 General Information for the SR 970 Teanaway River Bridge Mitigation Site

USACE IP Number	97-4-01124
HPA Permit Number	00-D4171-03
Township/Range/Section (impact)	T.20N, R.15E, S25
Mitigation Location	North side of SR 970 Teanaway River Br., Cle Elum, Kittitas Co.
Construction Date	1999
Monitoring Period	2000 to 2004
Year of Monitoring	5 of 5
Type of Mitigation	Riparian re-vegetation, channel relocation

Table 3.2 2004 Monitoring and Management Summary for the SR 970 Teanaway River Bridge Mitigation Site

Performance Criteria	2004 Results[10]	Management Activities
Permit Requirements		
1. $\geq$ 1.70 stems/m^2 on the site	1.07 stems/m^2 ($CI_{80\%}$ = 1.05-1.09 stems/m^2)	Irrigation/replanting
2. Control non-native invasive plants	15% aerial cover (qualitative)	Weed control

Permit Requirements

The fifth-year permit requirements for the SR 970 Teanaway River mitigation site were excerpted from the *United States Army Corps of Engineers Individual Permit 97-4-01124* (USACE 1997). A companion sampling objective follows Permit Requirement 1. Appendix 3.1 provides the text of the monitoring-related permit requirements for this project. Appendix 3.2 shows the planting plan (Sauriol and Smith 1999) and photo point locations.

[10] Estimated values are presented with their corresponding statistical confidence interval. For example, 1.07stems/m^2 ($CI_{80\%}$ = 1.05-1.09 stems m^2) means we are 80% confident that the density value is between 1.05 stems/m^2 and 1.09 stems/m^2.

Permit Requirement 1 (Special Condition h)
An 80% [planted woody species] survival rate shall occur at the end of the third-year monitoring period (2002). If 80% survival is not obtained, plants shall be replanted in the next planting season following the monitoring period where lack of survival was determined (2004).

Note: 80% survival is interpreted as a density of 1.7 stems per square meter. This allows both volunteer and planted woody species to be included (James Morin personal communication, April 2001).

> Sampling Objective 1
> To be 80% confident the true woody species stem density is within 20% of the estimated density.

Permit Requirement 2 (Special Condition h)
Control of non-native invasive plants during the 5-year vegetation-monitoring period (2000-2004).

Methods

Sampling was conducted to estimate woody species stem density (Permit Requirement 1) in both the riparian re-vegetation and stream channel relocation zones. For both zones, the unequal-area belt transect method was used to evaluate density. The following describes sampling strategies and methods implemented at the mitigation site this year.

Stream Channel Relocation Zone
A systematic random sampling method was used to position 40 one-meter wide belt transects perpendicular to a 160-meter baseline along the east bank of the secondary stream channel (Figure 3.1). Field crews identified and counted all trees and shrubs (planted and volunteer) within the boundaries of each belt transect. Transects were variable in length due to the irregular boundaries of the sampling area.

Riparian Re-vegetation Zone
Similar methods were employed along the riparian corridor. Forty-nine unequal-area, one-meter wide belt transects were positioned along a 198-meter baseline located parallel to the river channel. Trees and shrubs were identified and counted within the boundaries of each belt transect.

A qualitative assessment of invasive plant species cover was conducted for each of the re-vegetation zones (Permit Requirement 2).

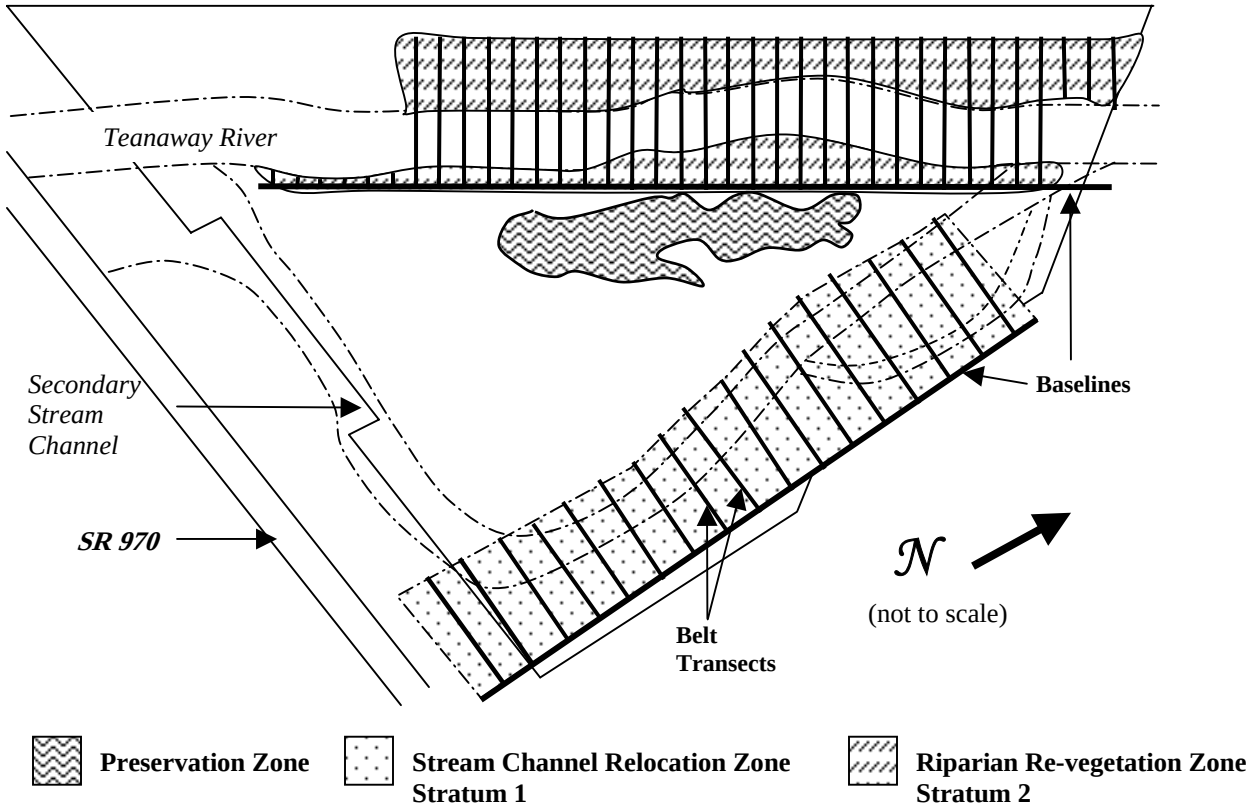


Figure 3.1 SR 970 Teanaway Riparian Re-vegetation Site Sampling Design (2004)

For additional details on the methods described above, see the Methods section of this report or view WSDOT Wetland Mitigation Site Monitoring Methods at: http://www.wsdot.wa.gov/environment/biology/docs/MethodsWhitePaper052004.pdf

Results and Discussion

Permit Requirement 1 – At Least 1.7 Stems/Meter^2

The stem density for woody species across the entire site (in the stream channel relocation and riparian re-vegetation zones combined) is estimated to be 1.07 stems/m^2 ($CI_{80\%}$ = 1.05-1.09 stems/m^2).

Photo 3.2 SR 970 Teanaway River woody plant establishment (September 2004).

Though this value does not meet the target (1.7 stems/m^2) specified in the permit, many of the original plantings have survived and are accompanied by colonization across the mitigation site (Photo 3.2). Density has decreased from 2003, but qualitative observations suggest that aerial cover by woody species has increased. It appears that fewer trees are providing more cover through a self-thinning process.

Secondary Stream Channel Relocation Zone.
Along the secondary stream channel, density was estimated to be 1.13 stems/m^2 ($CI_{80\%}$ = 0.95-1.31 stems/m^2). Colonization of *Populus balsamifera* (black cottonwood) and *Salix* species (willows) continues. Cover of trees and shrubs has increased in the secondary stream channel since 2003, with most areas of the channel estimated at 90% aerial vegetative cover. It has been difficult to establish plants in the southern half of this zone, while the north half of this zone has greater density of both planted and volunteer species (Photo 3.3). Replanting woody species may be beneficial in the open areas near the south end of the secondary stream channel.

Photo 3.3 **SR 970 Teanaway River woody vegetation (September 2004).**

Riparian Corridor Zone.
The riparian corridor has an estimated stem density of 1.02 stems/m^2 ($CI_{80\%}$ = 0.89-1.16 stems/m^2). The dynamic nature of the Teanaway River has made it difficult for the riparian woody vegetation to establish, although, some of the unaffected areas along the riparian corridor are more densely vegetated this year.
Periods of peak water flow have altered and scoured the riverbank resulting in loss of planted vegetation. *P. balsamifera* and *Salix* species have colonized some of the remaining areas along the bank of the Teanaway River. If the riverbank remains in its current configuration, the streambanks may re-vegetate naturally and meet the density standard.

Permit Requirement 2 – Control of Non-Native Invasive Plants

In 2004, aerial cover of invasive species was qualitatively estimated to be 15%. This estimate is markedly lower than the 2003 estimate of 35%. An aggressive weed control program, primarily targeting *Phalaris arundinacea* (reed canarygrass), has succeeded in reducing the cover of invasive species on site. Qualitative observations suggest that the tree and shrub community may be benefiting from the noticeable reduction of *P. arundinacea*, particularly in the secondary stream channel (Photo 3.4).

Photo 3.4 SR 970 Teanaway River invasives (September 2004).

The following additional invasive species were observed at low cover levels. These species do not appear to pose an immediate threat to site development.

- *Cardaria chalapensis* (lensepod whitecress)
- *Centaurea debeauxii* (meadow knapweed)
- *Centaurea diffusa* (diffuse knapweed)
- *Cirsium arvense* (Canada thistle)
- *Cirsium vulgare* (bull thistle)
- *Hypericum perforatum* (common St. Johnswort)
- *Kochia scoparia* (Mexican fireweed)
- *Leucanthemum vulgare* (oxeye daisy)
- *Melilotus alba* (white sweetclover)
- *Verbascum thapsus* (common mullein)

Appendix 3.1 - SR 970 Teanaway River Permit Requirements

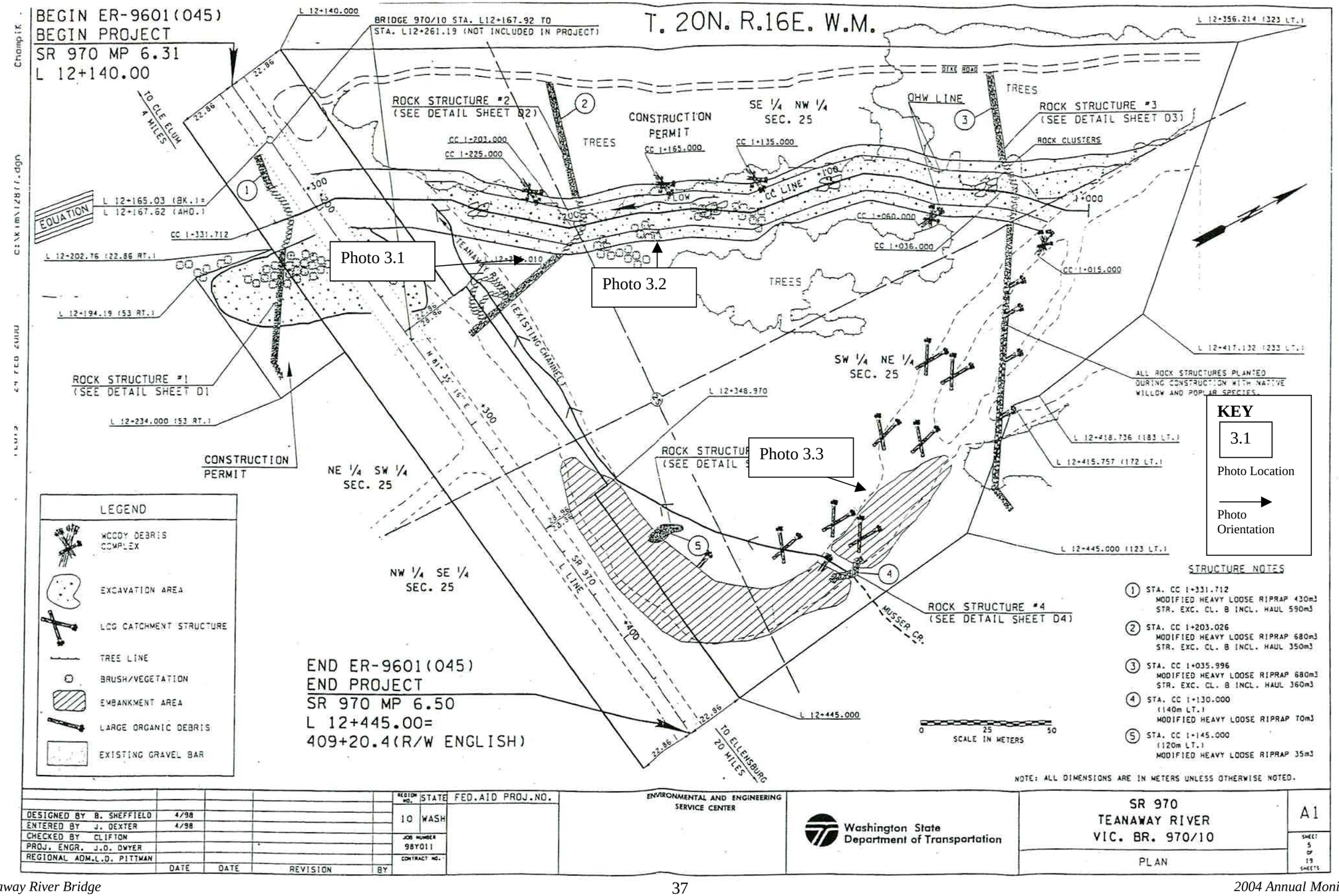
The following excerpt is from the *United States Army Corps of Engineers Individual Permit 97-4-01124* (USACE 1997). The criteria addressed this year are identified in **bold** font.

Special Condition e: A contingency plan shall be developed by WSDOT which will detail the following: actions to be taken in the event of adverse weather conditions during construction, a plan for the control of non-native invasive plants during the 5-year vegetation monitoring period, and a plan for replanting plants which do not meet the survival criteria specified in condition (h).

Special Condition h: Invasive plant control shall occur as specified in the contingency plan described in condition (e). An 80% survival rate shall occur at the end of the first, second, and third-year monitoring periods. If 80% survival is not obtained, plants shall be replanted in the next planting season following the monitoring period where lack of survival was determined.

Note: 80% survival is interpreted as a density of 1.7 stems per square meter on the site. This allows both volunteer and planted woody species to be included. (James Morin personal communication, April 2001).

Appendix 3.2 – SR 970 Teanaway River Planting Plan
(Sauriol and Smith 1999)



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Yakima County
SR 12 Naches River Bridge Replacement 12/320

USACE IP 94-4-00800

Photo 4.1 **Riparian vegetation at the SR 12 Naches River mitigation site (October 2004).**

SR 12 Naches River USACE IP 94-4-00800

This report summarizes management and monitoring activities completed by the Washington State Department of Transportation (WSDOT) at the SR 12 Naches River Bridge Replacement 12/320 (SR 12 Naches River) mitigation site from Fall 2003 through Fall 2004 (Photo 4.1). WSDOT Wetland Monitoring and Assessment Program activities were intended to address success standards for 2004. These activities included vegetation surveys, photo-documentation, and assessments of wetland hydrology. Table 4.1 provides general site information and Table 4.2 summarizes this year's monitoring results.

Table 4.1 General Information for the SR 12 Naches River Mitigation Site

USACE IP Number	96-4-00800	
Township/Range/Section (impact)	T.15/R.16E/S.35	
Mitigation Location	SR 12 Bridge over the Naches River, Yakima County	
Construction Date	1998/1999	
Initial Monitoring Period	2000-2004	
Year of Monitoring	5 of 5	
Area of Project Impact	2.09 acres	
Type of Mitigation	Buffer Creation	Buffer Enhancement
Area of Mitigation	0.40 acres	0.15 acres

Table 4.2 Monitoring and Management Summary for SR 12 Naches River Mitigation Site

Performance Criteria	2004 Results[12]	Management Activities
Success Standard		
1. 50% aerial cover by woody species	48% ($CI_{80\%}$ = 41 – 55% cover)	Weed control
2. ≥80% aerial cover in the emergent area, with 60% aerial cover of native species	70% ($CI_{80\%}$ = 63 – 82% cover) 99% relative cover by native species	

Success Standards and Sampling Objectives

The fifth-year success standards for the SR 12 Naches River mitigation site were excerpted from the *Final Wetland Mitigation plan for SR 12 Naches River Bridge Replacement 12/320 Wetland Mitigation Plan* (Smith and Russell 1996). Sampling objectives follow the success standards. Appendix 4.1 provides the complete text of the success standards for this project, and Appendix 4.2 shows the planting plan (Smith and Russell 1996).

[12] Estimated values are presented with their corresponding statistical confidence interval. For example, 48% ($CI_{80\%}$ = 41-55% aerial cover) means we are 80% confident that the true aerial cover value is between 41% and 55%.

Success Standards and Sampling Objectives

Success Standard 1
50% aerial cover of woody species in the scrub-shrub and forested zones of the site (2004).

> Sampling Objective 1
> To be 80% confident the true aerial cover of woody species is within 20% of the estimated cover value.

Success Standard 2
At least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native (2004).

> Sampling Objective 2
> To be 80% confident the true aerial cover in the emergent zone is within 20% of the estimated cover value.

Methods

A baseline was established parallel to SR12 to assess aerial cover of woody species in the scrub-shrub and forested zones (Figure 4.1) (Success Standard 1). Twenty-four temporary transects were placed perpendicular to a 107-meter baseline using a systematic random sampling method. Twenty-four 15-meter line-segment sample units were randomly positioned along the sampling transects (Success Standard 1).

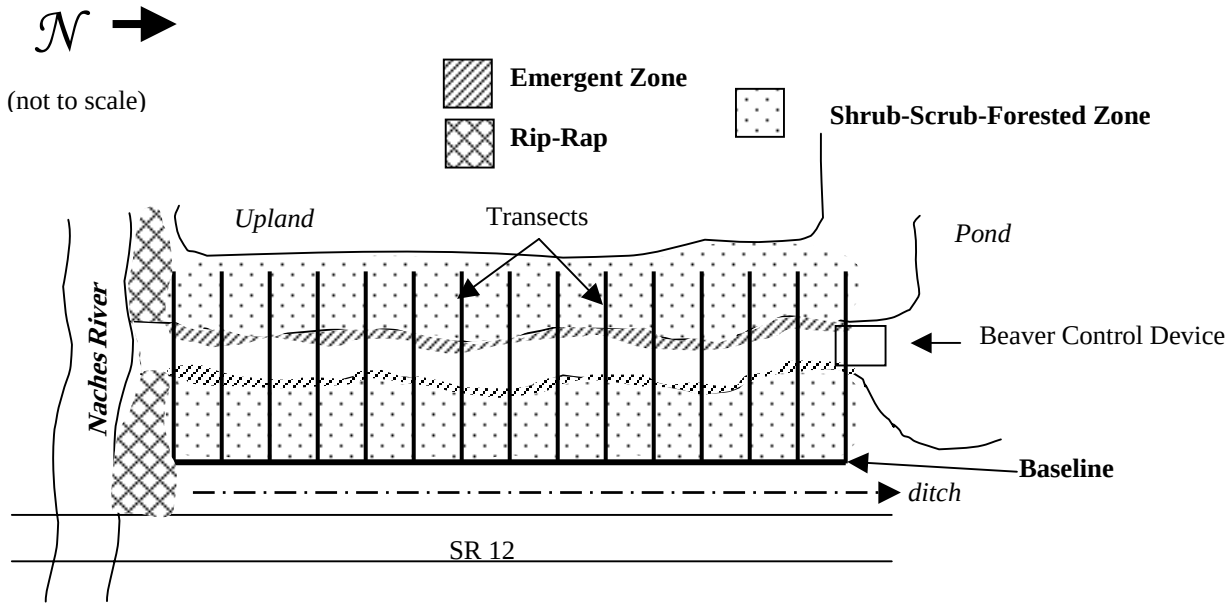


Figure 4.1 SR 12 Naches River Mitigation Site Sampling Design (2004)

To address Success Standard 2, aerial cover of herbaceous species was assessed in the emergent areas using the point-frame method. Fifteen randomly positioned 0.5 x 1.0 meter point-frame sample units (30 points each) were placed along the sampling transects.

Sample size analysis confirmed that sufficient sampling had been completed based on the sampling objectives and the desired level of statistical confidence. The following sample size equation was used to perform the analysis on data collected.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[13]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report or view WSDOT Wetland Mitigation Site Monitoring Methods at: http://www.wsdot.wa.gov/environment/biology/docs/MethodsWhitePaper052004.pdf

Results and Discussion

The SR 12 Naches River mitigation site offered a unique opportunity to provide wetland and river connectivity. To compensate for the loss of wetland functions due to project impacts, a new wetland/riparian mitigation channel was created west of the new roadway embankment. Functions replaced in this mitigation effort include wildlife habitat, food chain support, fish passage, and anadromous fish winter rearing habitat.

At the close of the five-year monitoring period, this effort appears to have been successful. By enhancing the connectivity to the established pond at the north end of the stream, fish passage and anadromous fish winter rearing habitat have been enhanced. Through successful planting and natural recruitment a native tree and shrub community of 14 species is developing on site (Table 4.3). This plant community provides habitat complexity, food chain support, opportunities for nesting and perching, fruit, seed, leaf litter production, and stream cover for salmonids. Seventeen species of birds were observed on site during the 5-year monitoring period.[14]

[13] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

[14] Bird species documented on site include: American Crow, American Goldfinch, American Robin, Barn Swallow, Belted Kingfisher, Black-headed Grosbeak, Cedar Waxwing, Cliff Swallow, Eastern Kingbird, Great Blue Heron, Lewis's Woodpecker, Pacific-slope Flycatcher, Red-winged Blackbird, Song Sparrow, Spotted Towhee, Tree Swallow, and Violet-green Swallow.

Table 4.3 Woody Species Observed at the SR 12 Naches River Mitigation Site (2004)

Scientific Name	Common Name	Fruit and Seed Producers (Cooke 1997)
Alnus rubra	red alder	No
Artemisia tridentata	big sagebrush	No
Cornus sericea	redosier dogwood	Yes
Ericameria nauseosa	grey rabbitbrush	Yes
Populus balsamifera	black cottonwood	No
Prunus virginiana	chokecherry	Yes
Purshia tridentata	antelope bitterbrush	Yes
Ribes aureum	golden currant	Yes
Robinia pseudoacacia	black locust	No
Rosa woodsii	Wood's rose	Yes
Salix exigua	sandbar willow	Yes
Salix lucida	Pacific willow	Yes
Sambucus nigra	blue elderberry	Yes
Symphoricarpos albus	snowberry	Yes

<u>Success Standard 1 – 50% Woody Cover in the Scrub–Shrub and Forested Zones</u>

Aerial cover of woody species in the scrub-shrub and forested zone (Photo 4.2) is estimated to be 48% ($CI_{80\%}$ = 41 – 55% cover). This estimate approaches the 50% standard and permit requirement set forth in the mitigation plan. Woody species are well developed and structurally complex, meeting the mitigation objective of replacing and enhancing wetland and riparian corridor development.

Photo 4.2 Woody cover in the scrub-shrub and forested zone of SR 12 Naches River mitigation site (October 2004).

Success Standard 2 – 80% Aerial Cover in the Emergent Zone, 60% Native Species

A quantitative estimate of aerial cover in the emergent zone (Photo 4.3) is 70% ($CI_{80\%}$ = 59-81% cover). This estimated value is below the 80% success standard and permit requirement. However, this zone is developing well with seven native facultative and wetter species present (Table 4.4). Native species were estimated to provide 99% of this cover, far exceeding the 60% nativity threshold.

Photo 4.3 **Aerial cover of wetland plants in the emergent zone of the SR 12 Naches River mitigation site (October 2004).**

Table 4.4 Facultative and Wetter Species Observed (2004) at the SR 12 Naches River Mitigation Site

Scientific Name	Common Name	Facultative Status
Carex stipata	Sawbeak sedge	Obligate
Epilobium ciliatum	Fringed willowherb	Facultative and Wetter
Equisetum hyemale	Scouringrush horsetail	Facultative and Wetter
Juncus effusus	Soft rush	Facultative and Wetter
Juncus tenuis	Slender rush	Facultative and Wetter
Myosotis laxa	Bay forget-me-not	Obligate
Scirpus maritimus	Seacoast bulrush	Obligate

The U.S. Army Corps of Engineers Nationwide Permit 96-4-00800 requires aerial cover in the scrub-shrub and emergent zones to be provided by species in Table 4 (see p. 46) of the *Final Wetland Mitigation plan for SR 12 Naches River Bridge Replacement 12/320 Wetland Mitigation Plan* (Smith and Russell 1996). Mortality of these species has been substantial with five of the fifteen species no longer present. This can largely be attributed to beaver herbivory and flooding early in the monitoring period. Subsequent re-vegetation of these zones has occurred with a diverse naturally colonizing community of other native plant species. Management intervention does not appear necessary as the areas appear to be developing toward the intended conditions as prescribed in Success Standard 2.

Additional Information

Weed control has been conducted both on site and in the surrounding area. Aerial cover of invasive species was qualitatively estimated to be two to three percent. Ongoing weed control has targeted noxious and undesirable plant species with an emphasis on *Cirsium arvense* (Canada thistle), *Verbascum thapsus* (common mullein), and *Salsola tragus*

(prickly Russian thistle). These efforts have effectively minimized the presence of these species.

Appendix 4.1 - SR 12 Naches River Success Standards

The following success standards are excerpted from the *Final Wetland Mitigation Plan for SR 12 Naches River Bridge Replacement 12/320* (Smith and Russell 1996). The standards addressed this year are identified in **bold** font.

Goals

The goals of the mitigation project replace the lost functions and values of the impacted wetlands, and provide a combination of diverse out-of-kind enhancements. WSDOT proposes to create 0.09 hectares (0.40 acres) of buffer, preserve 0.06 hectares (0.15 acres) of buffer, and preserve 0.14 hectares (0.34 acres) of existing wetland. It is intended that wetland and buffer creation and preservation will produce an ecologically diverse system, providing wildlife habitat and food chain support, surface water discharge, flood runoff attenuation in very large flood events, sediment/toxicant retention, and nutrient removal and transformation. These functions will enhance the riparian ecosystem of the Naches River corridor.

Objectives and Standards of Success

Objective: Create a wetland and riparian corridor community vegetated with a diverse mix of wetland and riparian plant species indigenous to the local area.

Standards of Success:
After five years (2004)

A 50% aerial cover of woody species in the scrub-shrub and forested zones of the site.

b. At least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native.

Contingency Plans

Mitigation goals will be accomplished with native plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems. Determinations of success of plantings and overall vegetation of the site will be guided by standards of success as stated.

In the event that aerial coverage of wetland forest, scrub-shrub, or emergent vegetation falls short of the listed performance standards, (i.e., year 5) the site will be replanted to bring it up to levels stated. The DOT environmental staff will coordinate with appropriate agencies to agree on remedial action.

Table 4. Planting list

Zone:	Species	Placement
Buffer	Ponderosa pine (*Pinus ponderosa*)	top of bank
	Smooth sumac (*Rhus trilobata*)	edge of bench to toe of road
	Woods rose (*Rosa woodsii*)	edge of bench to toe of road
	black cottonwood (*P. balsamifera*)	middle of bench to toe of road
	snowberry (*Symphoricarpos alba*)	edge of bench to top of bank
	native erosion control dry grass mix (sp. varies)	edge of bench to top of bank
Scrub/Shrub	black cotton wood (*P. balsamifera*)	channel slope to edge of bench
	pacific willow (*S. lasiandra*)	channel slope to edge of bench
	red stemmed willow (*Salix sp*.)	channel slope to edge of bench
	red osier dogwood (*C. stolinifera*)	emergent to middle of bench
	sandbar willow (*Salix exigua*)	middle to edge of bench
	wild iris (*Iris missouriensis*)	emergent to toe of road
Emergent	spike rush (*Eleocharis palustris*)	emergent to middle of bench
	local sedge (*Carex* sp.)	emergent to middle of bench
	sm. fruited bulrush (*S. microcarpus*)	emergent to middle of bench
	pondweed (*Potamogeon* sp.)	emergent

NOTE – All plantings and cuttings to be taken from local area if possible.

Additional Permit Requirements

Excerpted from the U. S. Army Corps of Engineers Nationwide Permit 96-4-00800 (Department of the Army 1996)

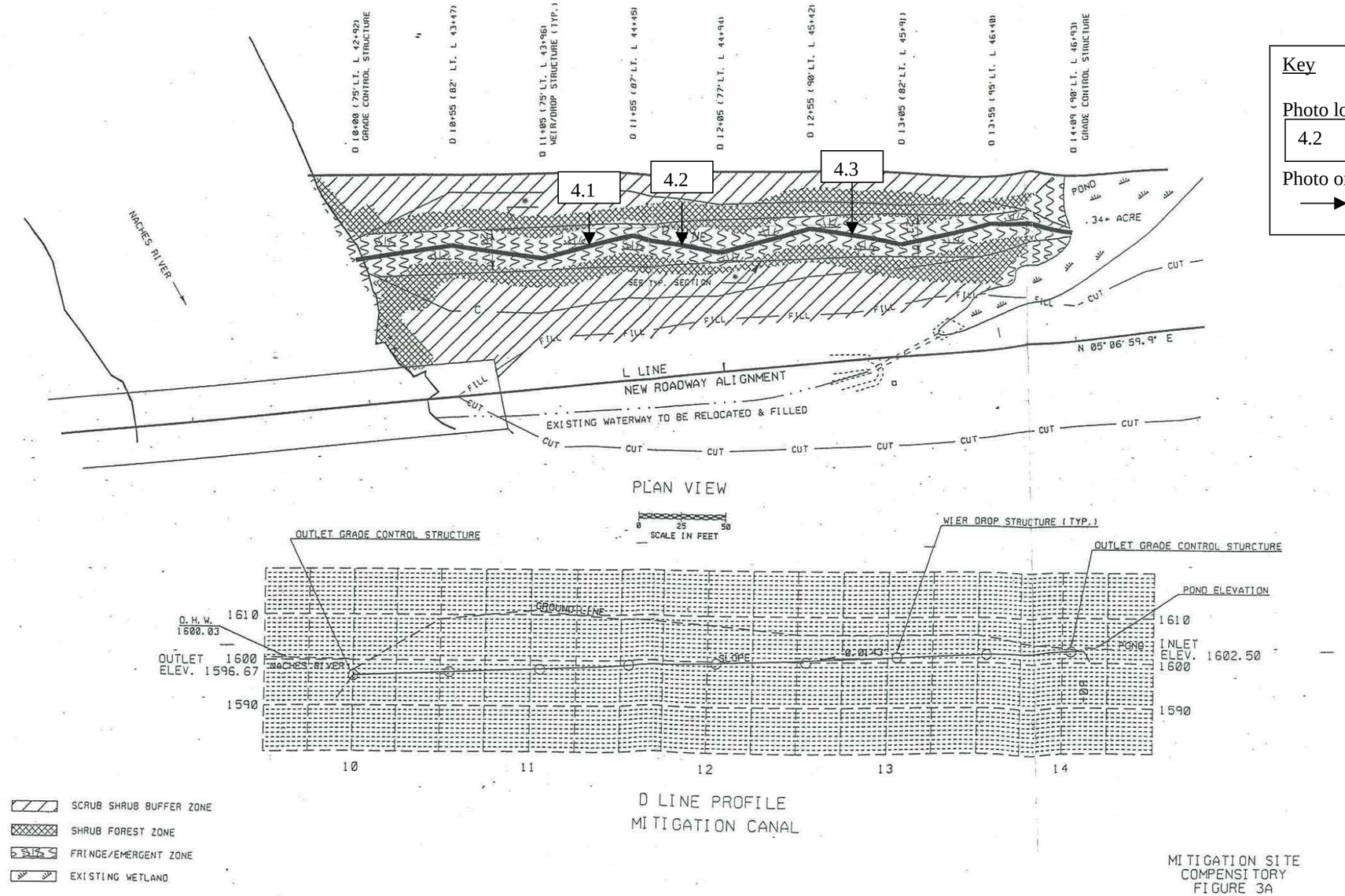
Special Condition E

Vegetation at the 5 year monitoring inspection will meet at least 50% aerial cover of scrub-shrub and forested plant species as listed in Table 4 of the wetland mitigation plan dated May 20, 1996 under "Buffer" and "Scrub/Shrub".

Special Condition F

Vegetation at the 5 year monitoring inspection will meet at least 80% aerial cover of emergent plants as listed in Table 4 of the wetland mitigation plan dated May 20, 1996 under "emergent".

Appendix 4.2 – SR 12 Naches River Planting Plan
(from WSDOT 1996)



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SR 97 Toppenish Creek Bridge Replacement

USACE NWP 2000-4-01285

Photo 5.1 SR 97 Toppenish Creek mitigation site box culvert at MP 57.50 (October, 2004).

SR 97 Toppenish Creek Bridge Replacement
USACE NWP 2000-4-01285

This report summarizes vegetation monitoring results and management activities completed by the Washington State Department of Transportation (WSDOT) at the SR 97 Toppenish Creek Bridge Replacement (SR 97 Toppenish Creek) mitigation site from August 2003 to August 2004. WSDOT Wetland Monitoring and Assessment Program activities were intended to address the permit requirement for 2004. Table 5.1 provides general site information and Table 5.2 summarizes this year's monitoring results.

Table 5.1 General Information for the SR 97 Toppenish Creek Bridge Replacement Mitigation Site

USACE NWP 23 Number	2000-4-01285	
Township/Range/Section (impact)	T.10 N/R.20E/S.28 and 33	
Mitigation Location	SR 97 MP 56.78 to 58.25, Yakima County	
Construction Dates	2002-2003	
Initial Monitoring Period	2004 to 2008	
Year of Monitoring	1 of 5	
Type of Project Impact	Permanent Fill	Temporary Fill
Area of Project Impact	0.2640 acres	0.7451 acres
Type of Mitigation	Install 8 Box Culverts	Replanted Wetland
Area of Mitigation	N/A	0.5000 acres

Table 5.2 Monitoring and Management Summary for SR 97 Toppenish Creek Bridge Replacement Mitigation Site

Permit Requirement	2004 Results[15]	Management Activities
Less than 10% invasive species	75% ($CI_{90\%}$ = 67-84%)	Weed control

Success Standards and Sampling Objectives

The permit requirement for this mitigation site was excerpted from the *USACE NWP 23/33 2000-4-1285*. A companion sampling objective follows the permit requirement. Appendix 5.1 provides the complete text of the future success standards and additional permit requirements for this project.

Permit Requirement

Any re-vegetated areas may show no more than 10% invasive species for the total area (2004).

Sampling Objective

To be 80% confident that the true invasive species cover value is within 20% of the estimated value.

[15] Estimated values are presented with their corresponding statistical confidence interval. For example, 22% ($CI_{80\%}$ = 18-26% aerial cover) means we are 80% confident that the true aerial cover value is between 18% and 26%.

Methods

A baseline was established parallel and downstream of SR 97 to evaluate the forested and scrub-shrub wetland area (Figure 5.1). Five temporary sampling transects were placed perpendicular to the baseline in front of six culverts using a systematic random sampling method. To collect information on invasive and native herbaceous species, the point-intercept method was used and thirty 10-meter point-line sample units (20 points each) were randomly positioned along the sampling transects (Success Standard 1 and Permit Requirement).

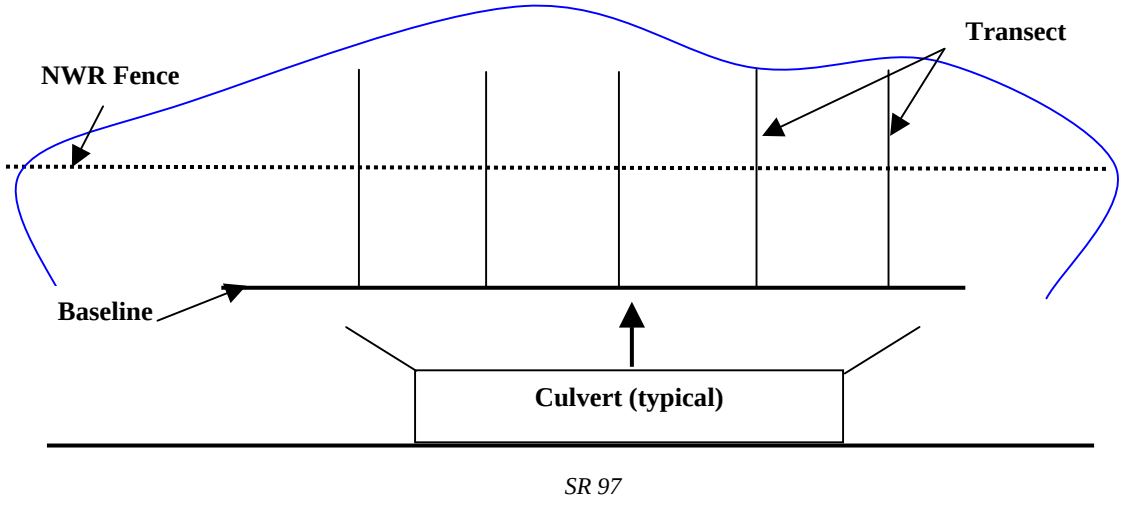

Figure 5.1 SR 97 Toppenish Creek Mitigation Site Sampling Design for a Typical Culvert (2004)

Sample size analysis confirmed that sufficient sampling had been completed based on the sampling objectives and the desired level of statistical confidence. The following sample size equation was used to perform the analysis on data collected.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[16]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report or view WSDOT Wetland Mitigation Site Monitoring Methods at:
http://www.wsdot.wa.gov/environment/biology/docs/MethodsWhitePaper052004.pdf

[16] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Results and Discussion

To improve floodplain connectivity and enhance existing nonnative plant communities in the Toppenish Creek Basin, WSDOT installed eight box culverts underneath SR 97 three miles south of the city of Toppenish. Project goals include an increase in native vegetation at culvert outflows. In October 2003, the region planted four of the box culverts with 2,050 native woody plants. In October 2004, 1,060 additional native woody plants were installed by the remaining four culverts between the weigh station and the NWR gate. Photographs of the culverts are included in Appendix 5.2. Survival of these plants will be monitored in 2005.

Permit Requirement – No More Than 10% Aerial Cover by Invasive Species

Control of invasive species began in August 2003 and was conducted from the weigh station to the NWR gate. Additional weed control began in the northern section (MP 57.36-57.60) in the summer of 2004 and continued throughout the growing season. Despite these efforts, aerial cover provided by invasive species on six of the culverts in August 2004 was estimated to be 75% ($CI_{90\%}$ = 67-84% cover). Most of this cover was provided by *Phalaris arundinacea* (reed canarygrass). Other species of concern including *Lepidium latifolium* (broadleaved pepperweed), *Dipsacus fullonum* (Fuller's teasel), and *Cirsium arvense* (Canada thistle) contributed to the above cover estimate.

Appendix 5.1 – SR 97 Toppenish Creek Permit Requirements

The following excerpt is from the USACE NWP 23/33 2000-4-1285:
Page 1 Special Condition 2:
All temporarily impacted wetlands must be re-graded and re-vegetated according to the referenced mitigation plan with 12 months of the date of this permit, in accordance with the SR 97 Toppenish Creek Bridge Replacement, Final Wetland Mitigation Plan, dated February 2001.

Page 3 Mitigation
CONDITIONS

1. **As-built drawings for all mitigation work must accompany first annual monitoring report.**
2. Any re-vegetated areas must show a minimum of 80% survival per species at the end of each year as shown in the monitoring report.
3. **Any re-vegetated areas may show no more than 10% invasive species for the total area as shown in the monitoring report.**
4. The annual monitoring report shall include a brief statement from the Yakima Nation Water Code Administration concerning any effects of the enhanced hydrological connectivity allowed by the new culverts, if any have occurred that year.
5. The wetland area created as mitigation for work authorized by this permit, shall not be made the subject of a future individual or general Department of the Army permit application for fill or other development, except for the purposes of enhancing or restoring the mitigation associated with this project. In addition, a description of the mitigation area identified in the final mitigation plan as approved, and any subsequent permit mitigation area revisions, will be recorded with the Registrar of Deeds or other appropriate official charged with the responsibility for maintaining records to or interest in real property. Proof of this documentation must be provided to the Corps of Engineers, Seattle District, prior to construction.
6. A status report on the mitigation, construction, including as-built must be submitted to the Regulatory Branch, Corps of Engineers, 13 months from the date of permit issuance. Annual status reports are required until mitigation construction is complete.
7. The SR 97 Toppenish Creek Bridge Replacement, L2889, Final Wetland Mitigation Plan, dated February 2001, must be implemented. Mitigation monitoring reports will be due annually after the mitigation work is completed. All reports must be submitted to, Seattle District, Regulatory Branch.

SR 97 Toppenish Success Standards

The following excerpt is from the *SR Toppenish Creek Bridge Replacement Final Wetland Mitigation Plan* (McQueary 2001). The performance criteria addressed this year are identified in **bold** font.

1.4.2 Goals and Objectives

1.4.2.1 Goals

Washington State Department of Transportation, in cooperation with the Yakima Nation, has determined that the best mitigation procedure is to provide for floodplain

connectivity, compromised by SR 97. The goal of WSDOT is to correct problems of floodwater impoundment and lost connectivity associated with SR 97. This will be accomplished through the installation of eight box culverts, located on site. The long-term goal of the project is to reestablish floodplain connectivity, and to cooperate in the restoration and enhancement of several hundred acres within the Toppenish Creek Basin. The wetlands to be restored and enhanced are mainly Palustrine emergent and scrub-shrub. The main function to be restored is the flood storage capacity and attenuation of floodwaters. However, there should also be an increase in habitat for waterfowl and amphibians associated with the project.

1.4.2.2 Objectives

Objective A: To lessen the impacts of floodwaters in the area and avoid road closures.
Objective B: To enhance and restore wetland vegetation downstream of SR 97.

1.4.3 Performance Standards

Objective A: To lessen the impacts of floodwaters in the area and avoid road closures.
Performance standard: On completion of the bridge replacement project, road closures should be significantly reduced or eliminated. Flow through the main channel should be reduced and flow through box culverts should increase.

Objective B: To enhance and restore wetland vegetation downstream of SR 97.
Performance standard: The downstream vegetation is currently limited to agricultural non-native grasses and invasive species. The installation of the box culverts should increase wetland vegetation at least at the outlets. This will be measured by a 50% increase in obligate and facultative native species in the areas adjacent to the box culverts within two growing seasons following construction.

1.5.2 Ownership

Washington State Department of Transportation currently has an easement through the Yakima Nation Tribal Land for SR 97. WSDOT will be responsible for maintenance of the culverts in perpetuity. WSDOT will also be responsible for any adjustments necessary should the culverts prove to be unsuccessful. Water control structures exist upstream and are controlled by U.S. Fish and Wildlife Service, the Yakima Nation, and an irrigation district. However, this project is not dependent on a controlled water supply and is specifically related to flood flows.

1.6 Monitoring Plan

WSDOT proposes to install eight 12’ x 6’ box culverts at locations to be determined by the engineering staff in cooperation with the Yakima Nation Natural Resources Department. The locations will correspond to former flood channels and have been identified by Yakima Nation Hydraulics and Fisheries personnel. The new bridge will have a much higher and wider span, allowing in unimpeded flood flows. The culverts will be buried approximately 2’ to 3’, leaving an opening of 12’ x 4’ or 12’ x 3’. This will allow natural sediment to deposit, simulating a natural streambed.

Areas disturbed during construction will be replanted with native vegetation. The proposed vegetation source will consist of the selective harvest of native vegetation located in the general project vicinity. Native plant and grass species used to re-vegetate the site, but obtained from areas outside the project vicinity, will consist of varieties chosen for their compatibility with the project vicinity climate regime. Supplemental planting and placement will occur utilizing native stock from within WSDOT Right of Way, or as directed by the WSDOT Engineer in conjunction with the SCR Environmental Office.

1.6.1 Water Regime

The major goal of this project is to restore hydrological connectivity within the Toppenish Creek Basin. This is in conjunction with a basin-wide restoration plan that the Yakima Nation has had in place since 1989. There is currently little hydrological data available for this portion of Toppenish Creek. At this point, WSDOT has the opportunity to provide some baseline data prior to construction of the new bridge and culvert. Monitoring can begin in April of 2001, to establish baseline data in which to compare subsequent years. Attached is a copy of a map provided by the Yakima Nation showing the extent of flooding in 1996 and 1997. As per conversations with Ted Rapasky of the Yakima Nation, the installation of the box culverts should lessen the impact of floodwaters. Future floodwaters should not exceed those shown on the map (Rapasky 2000). Hydrological data from a USGS stream-gauging station on Toppenish Creek near Fort Simcoe from 1909-1920 is included in the Appendices. Hopefully, this data will provide some insight into past conditions and give some indication of historic flaws. Part of the monitoring plan will include aerial photo interpretation, and will require flights every two years to assess the success of the mitigation plan. In conjunction with the flood data provided by the Yakima Nation, this data should allow a comparison on an area basis to gauge the magnitude of flooding. The following data will also be incorporated into the monitoring plan and includes the estimated discharge during peak flood flows and the water surface elevation at the bridge:

Discharge		WSEL at bridge
2 yr	18.9 in (48 cm)	730.64 ft (222.70 m)
10 yr	42.13 in (107 cm)	
25 yr	56.69 in (144 cm)	
50 yr	68.9 in (175 cm)	
100 yr	83.46 in (212 cm)	733.66 ft (223.62 m)
500 yr	114.96 in (292 cm)	134.84 ft (223.98 m)

Starting in April of 2001, flow readings will be taken at least once a week at the bridge.
A more detailed description of hydrological monitoring is included in the Appendices.

The yearly assessment will also include any additional information regarding wetland functions; such as increase or decline in waterfowl and reestablishment of wetland vegetation downstream of the project area.

1.6.2 Vegetation

Vegetation monitoring will done through the use of aerial photograph interpretation and ground verification of the data. The survival rate of plants at re-vegetation sites shall be 80% the first

year, with replacement occurring during the appropriate seasonal windows. The area directly downstream of the box culverts will be monitored and assessed twice a year, in spring and early fall. Species composition will be measured using a line transect method. The two transects will be placed five meters apart and parallel to SR 97, beginning at the first culvert and ending at Toppenish Creek. Plot samples of 10.76 ft^2 (1 m^2) will be taken randomly along the transect. If the site contains 10% or more invasive or exotic plant species, spot herbicide application may be used. Shrub species will be measured when planted, and growth and survival will be tracked for five years. The percent cover and density of each plant stratum and species will also be recorded.

1.7 Maintenance and Contingency Plans

1.7.1 Contingency Plan

The contingency plan is based on the connectivity of the floodplain. If, in the future, the culverts do not provide adequate flow or dewater upstream wetland areas that are considered important for wildlife habitat, a review of the problem by WSDOT, Yakima Nation, and other pertinent resource agencies will be arranged to facilitate a possible remedy. Mortality in the plant community will be replaced as needed.

1.7.2 Maintenance

Maintenance of the SR 97 Bridge and culverts will be the responsibility of WSDOT.

Appendix 5.2 - SR 97 Toppenish Creek Mitigation Site - Box Culvert Photos (12 October 2004)

Culvert at MP 57.01

Culvert at MP 57.12

Culvert at MP 57.18

Culvert at MP 57.24

Culvert at MP 57.36

Culvert at MP 57.45

Culvert at MP 57.50

Culvert at MP 57.60

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Photo 6.1 Macroplot 1 wetland looking northeast at the SR 823 Selah mitigation site (August 2004).

SR 823 Selah Yakima Interconnect USACE IP 97-4-01405

This report summarizes monitoring and management activities completed by the Washington State Department of Transportation (WSDOT) Wetland Assessment and Monitoring Program at the SR 823 Selah Yakima Interconnect (SR 823 Selah) mitigation site from Fall 2003 through Fall 2004 (Photo 6.1). Final-year success standards (2005) were used to evaluate site development in 2004. Monitoring activities included assessments of native woody and invasive species cover in the wetland zones. Table 6.1 provides general site information and Table 6.2 summarizes this year's monitoring results.

Table 6.1 General Information for the SR 823 Selah Mitigation Site

USACE IP Number	97-4-01405	
Mitigation Location	SR 150 Harlan Landing at the Yakima River, Yakima County	
Township/Range/Section (impact)	T.13N/R.18E/S.12,SW/4, NW/4	
Construction dates	1999/2001	
Initial Monitoring Period	2001 to 2005	
Year of Monitoring	7 of 8	
Area of Project Impact	0.88 acres	
Type of Mitigation	Wetland Enhancement/Creation	Buffer Enhancement
Area of Mitigation	3.20 acres	0.80 acres

Table 6.2 Monitoring and Management Summary for SR 823 Selah Mitigation Site

Performance Criteria	2004 Results[16]	Management Activities
2005 Success Standard		
1. $\geq$ 50% woody cover in forested wetland, at least 3 species	Macroplot 1: 20% aerial cover[17] Macroplot 2: < 5% aerial cover	Summer irrigation
2. $\leq$ 10% non-native species	Macroplot 1: 4% ($CI_{80\%}$ = 3%-5%) Macroplot 2: 5% ($CI_{80\%}$ = 4%-7%)	Weed control

Success Standards and Sampling Objectives

The final year success standards were excerpted from the *SR 823 Selah – Yakima Interconnect Final Wetland Mitigation Plan* (Watson and Russell 1995). A sampling objective follows the success standard where appropriate. Appendix 6.1 provides the complete text of the success standards for this project and Appendix 6.2 shows the planting plan (Watson and Russell 1995) and photo locations.

[16] Estimated values are presented with their corresponding statistical confidence interval. For example, 4% ($CI_{80\%}$ = 3-5% aerial cover) means we are 80% confident that the true aerial cover value is between 3% and 5%.

[17] The site is divided into two sections by a preservation area. Macroplots were used in each section to facilitate data collection.

Success Standard 1
The site will have attained greater than or equal to 50% cover by at least 3 woody species in the forested and scrub–shrub zones of the wetland (2005).

Success Standard 2
Cover of non-native species will not exceed 10% (2005).

> Sampling Objective 2
> To be 80% confident that the true aerial cover of non-native species is within 20% of the aerial cover estimate in planted areas.

Methods

The site is divided into two sections by a preservation area. These two areas have exhibited differing vegetative development and subsequent management. In order to obtain separate data for continued adaptive management, the two areas were monitored separately by placing a macroplot on each side of the preservation area. Figure 6. 1 shows a diagram of the sampling design.

Qualitative data were collected on aerial cover of woody species in the forested and scrub-shrub zone of the wetland in Macroplot 1 and Macroplot 2 (Success Standard 1). The point-intercept method was used to estimate aerial cover of undesirable non-native species in both macroplots.

Macroplot 1
The baseline for Macroplot 1 was placed on the southwest edge of the site parallel to the Yakima River. Thirty temporary transects were placed perpendicular to the baseline using a systematic random sampling method. Transects terminated at the edge of the preservation area. Twenty-five 50-meter point-line sample units (200 points/unit), were randomly placed along sampling transects (Success Standard 2).

Macroplot 2
The baseline for Macroplot 2 was placed along the fence-line adjacent to the highway. Thirty transects were placed perpendicular to the baseline using a systematic random sampling method. Thirty 30-meter point-line sample units (120 points/unit), were randomly placed along sampling transects (Success Standard 2).

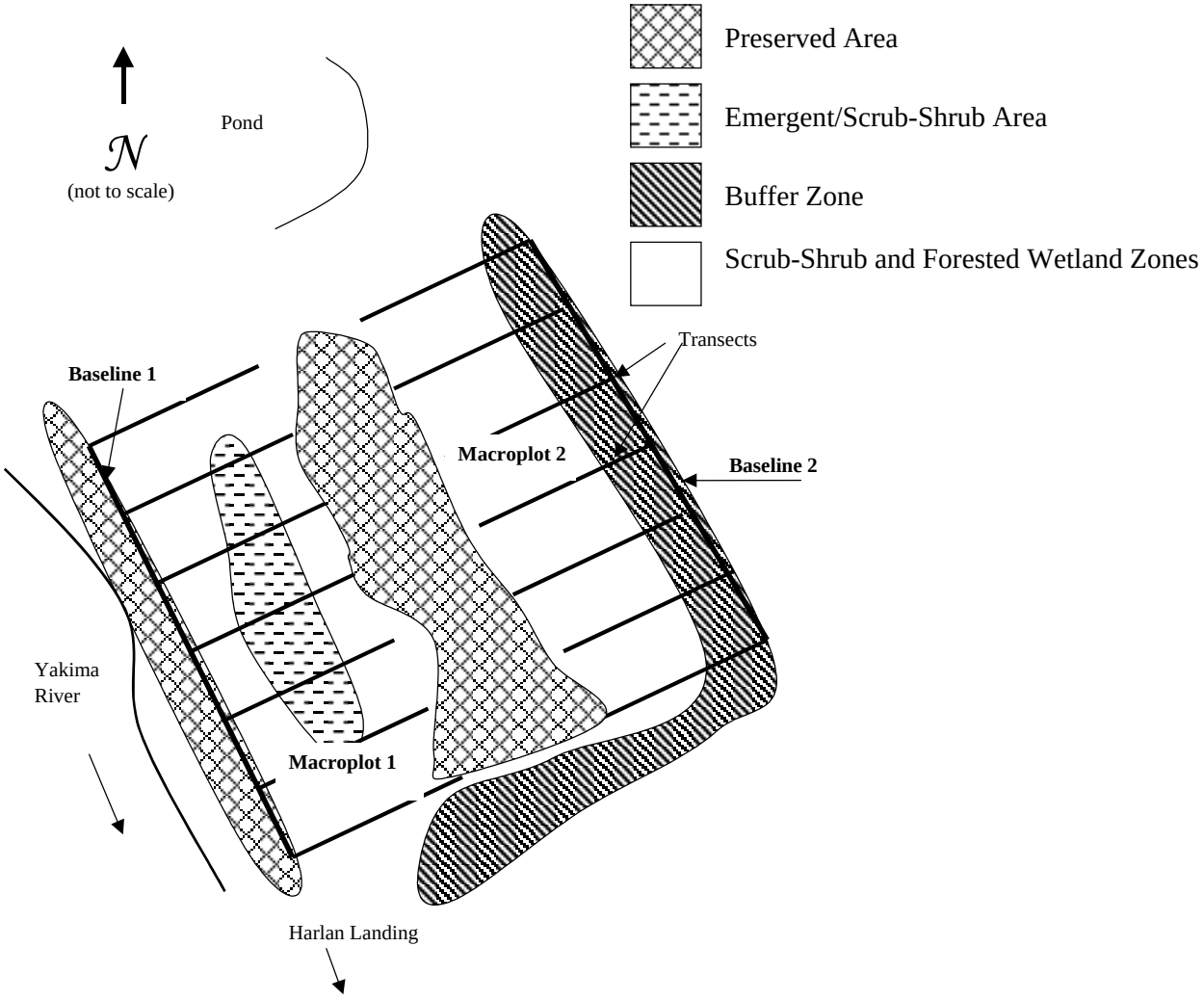


Figure 6.1 **SR 823 Selah Mitigation Site Sampling Design Sketch (2004).**

Sample size analysis confirmed that sufficient sampling had been completed based on the sampling objectives and the desired level of statistical confidence. The following sample size equation was used to perform the analysis on data collected.

Sample size analysis was conducted using the following equation.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[19]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report or WSDOT Wetland Mitigation Site Monitoring Methods at:
http://www.wsdot.wa.gov/environment/biology/docs/MethodsWhitePaper052004.pdf

[19] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Results and Discussion

Success Standard 1 – Greater than 50% Woody Cover in Forested/Scrub-Shrub Zones
Qualitative estimates for woody species cover are 20% and less than 5% in Macroplot 1 and Macroplot 2, respectively. These estimates indicate that overall woody cover in the forested and scrub-shrub zones is considerably lower than the 50% intended for 2005. Although woody cover is low, plants are well established with 12 species observed on site in 2004 (Table 6.3).

Differences observed between the east (Macroplot 2) and the west (Macroplot1) sides of the site may be due to a number of factors. Planted materials in Macroplot 1 (Photo 6.2) have benefited from favorable soil and hydrologic conditions. Macroplot 2 initially suffered from poor soil and hydrologic conditions before mid-course management activities occurred.

Re-grading Macroplot 2 favorably altered the hydrologic regime benefiting native plantings and increasing colonization in the area. Irrigation will continue in Macroplot 2 through the 2005 growing season.

Photo 6.2 **SR 823 Selah Macroplot 1 wetland woody cover (August 2004).**

Table 6.3 Woody Species Observed in the wetland at the SR 823 Selah Mitigation Site (2004)

Scientific Name	Common Name	Height Estimates (Meters)
Betula occidentalis	water birch	1.0-2.0
Cornus sericea	red-osier dogwood	0.5-1.0
Crataegus douglasii	black hawthorn	0.5
Populus balsamifera	black cottonwood	1.0-2.0
Populus tremuloides	quaking aspen	0.5-1.5
Salix lucida	pacific willow	1.0-2.0
Salix exigua	sandbar willow	1.0-2.0
Symphoricarpos albus	common snowberry	0.5
Amelanchier alnifolia	western service berry	0.5-1.0
Ribes aureum	golden currant	1.0
Rosa sp	rose	1.0
Sambucus nigra	blue elderberry	0.5

Success Standard 2 – Less than 10% Cover by Non-Native Species

Data were collected on invasive species as a substitute for non-native species. The aerial cover estimate of invasive species in Macroplot 1 was 4% ($CI_{80\%}$ = 3 – 5% cover) and in Macroplot 2 was 5% ($CI_{80\%}$ = 3-7% cover). These values are below the 10% threshold and achieve Success Standard 2. Noxious weed control has been an ongoing management focus since site construction. Efforts have focused on *Kochia scoparia* (Mexican fireweed), *Lepidium latifolium* (broadleaved pepperweed), and *Salsola tragus* (prickly russian thistle). The above monitoring results suggest these efforts have been effective.

Additional Information

Survival and stem density data were collected in both macroplots to gauge the effectiveness of continued irrigation efforts and replanting in 2002 and 2004 (Table 6.4). Survival was based on plants present at the time of monitoring so did not include dead plants that were no longer visible or present. Although stem density in both macroplots appears low, woody species continue to colonize the site. Continued irrigation and the addition of 2600 plants in the spring of 2004 should aid in the development of woody cover.

Table 6.4 Survival and Stem Density Data at the SR 823 Selah Mitigation Site (2004)

	Macroplot 1	**Macroplot 2**
Survival	90% ($CI_{80\%}$ = 3%-5%)	70% ($CI_{80\%}$ = 72% - 88%)
Density	0.9 stems/m^2 ($CI_{80\%}$ = 0.71-1.09)	0.3 stems/m^2 ($CI_{80\%}$ = 0.25-0.35)

Appendix 6.1 - SR 823 Selah Success Standards

The following excerpted is from *the SR 823 Selah – Yakima Interconnect Final Wetland Mitigation Plan* (Watson and Russell 1995). The standards addressed this year are identified in **bold** font.

Mitigation Goals

The goals of wetland mitigation are to replace the lost functions and values of the impacted wetlands. WSDOT proposes to create 1.30 ha (0.80 acres) of mixed palustrine forested/ scrub-shrub/ emergent wetland and 0.33 ha (0.80 acres) of buffer. In addition a buffer area of 0.17 ha (0.41 acres) would be preserved. It is intended that creation of the wetland will produce an ecologically diverse system providing wildlife habitat & food chain support, ground water discharge, flood attenuation in very large flood events, sediment/ toxicant retention and nutrient removal & transformation. These functions will enhance the riparian ecosystem of the Yakima River corridor.

Because this site has the potential for some contact by park users, an interpretive sign is being developed for prominent placement in the mitigated area. This sign will contain basic wetland ecology information and a request to leave the wetland area undisturbed.

Objectives and Standards of Success

Objective: Create a wetland community vegetated with a diverse mix of wetland and riparian plant species similar to those natural to the area.

Standards of Success: *after five years* (Revised 2002)

a. The site will have attained greater than or equal to 50% cover by at least 3 woody species in the forested and scrub-shrub zones of the wetland.

b. The emergent zone will have an overall vegetative cover of greater than or equal to 85%; **cover of non-native species will not exceed 10%** (Revised 2002). [20]

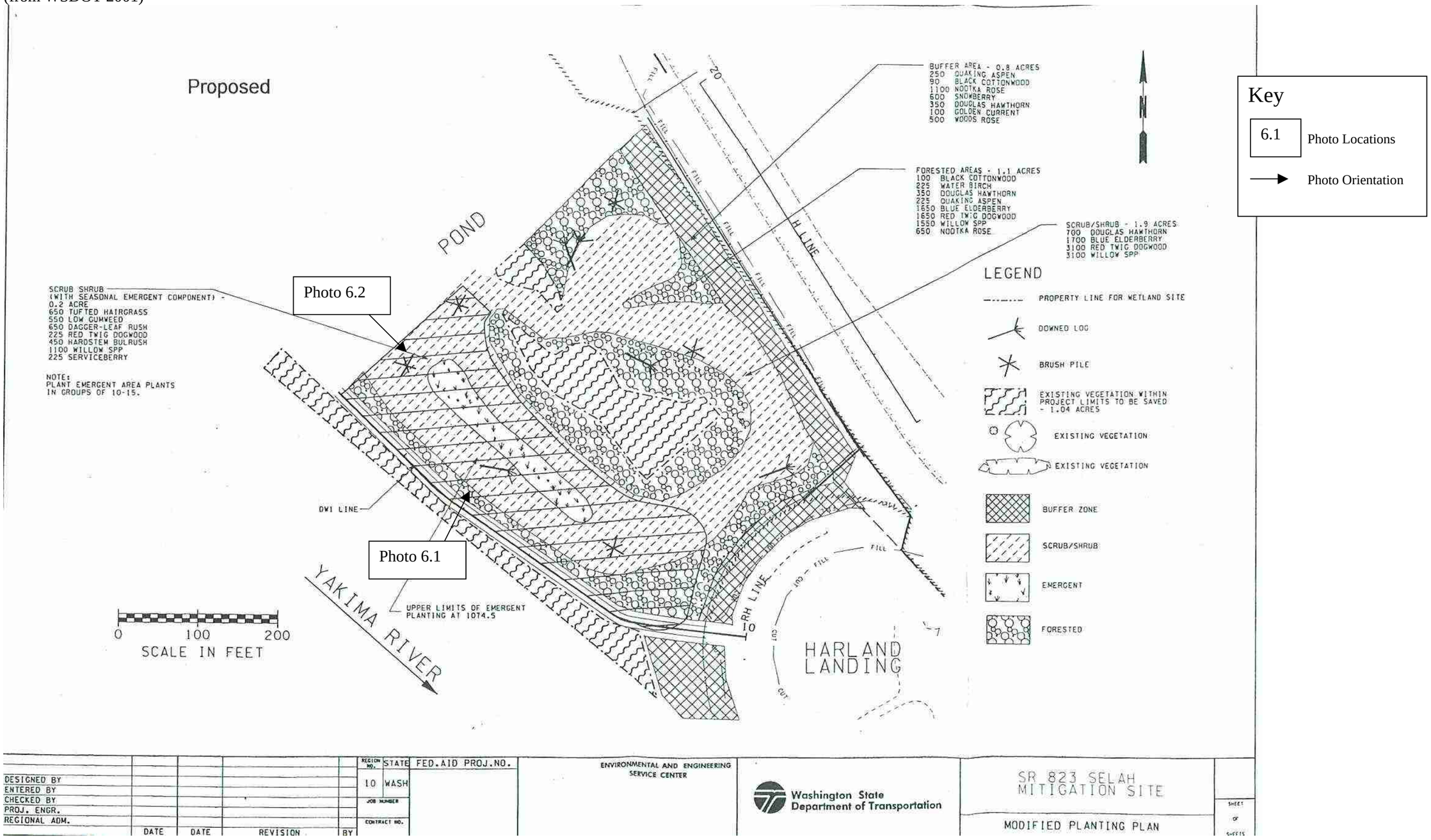
Contingency Plans

Mitigation goals will be accomplished with successful native vegetation plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems.

[20] Site management has altered the portion of the site that was initially intended as emergent. An official revision has been made making the emergent zone part of the standard obsolete.

In the event that aerial coverage of wetland forest, scrub-shrub or emergent vegetation falls short of the listed performance standards, additional measures will be employed to assure the establishment of a viable wetland plant community at the site. These measures include regrading the site in the event that the hydrology is too deep or otherwise insufficient for plant success.

Appendix 6.2 - SR 823 Selah Planting Plan
(from WSDOT 2001)



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Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the percent of ground surface covered by vegetation of a particular species (or suite of species) when viewed from above (Elzinga et al. 1998). Values for aerial cover are typically obtained from point-line, point-frame, or line-intercept data. Aerial cover does not include overlapping cover of separate plants, thus it does not exceed 100%.

Areal estimates – are made using the known boundary of a feature or statistical population. Areal estimates are often expressed in units of area.

Aquatic vegetation – includes submerged and rooted (*Elodea, Myriophyllum*) or floating (non-rooted) plants (*Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar, Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Community – a group of populations of species living together in a given place and time.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width.

Density – the number of plants per unit area (typically square meters).

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) device that includes horizontal and vertical leveling and a mirror to locate a precise vertical point in space either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.

FAC/Facultative – 1) Biological Definition: capable of adaptive response to varying environments (i.e., presence or absence of oxygen). 2) USFWS Indicator Status: Equally likely to occur in wetlands or in non-wetlands (estimated probability 34%-66%) (Reed 1988).

FACU/Facultative Upland – USFWS Indicator Status: Usually occur in non-wetlands (estimated probability 1%-<33%), but occasionally occur in wetlands (Reed 1988).

FACW/Facultative Wetland – USFWS Indicator Status: Usually occurs in wetlands (estimated probability 67%-99%), but occasionally occur in non-wetlands (Reed 1988).

Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – a plant that interferes with management objectives on a specific site at a specific point in time (Whitson et al. 2001). For monitoring purposes, invasive species include those listed on the current County Noxious Weed List, and on a site-by-site basis, other species may be included (such as *Rubus armeniacus* (Himalayan blackberry)).

Line-segment – a linear sample unit that is used to measure vegetative cover.

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats, line-segments or point-lines (Elzinga et al. 1998).

Obligate Upland - USFWS Indicator Status: Occur almost always in non-wetlands (estimated probability >99%) under natural conditions in the region specified. If a species does not occur in wetlands in any region, it may not be on the National List, and is designated Not Listed (NL) (Reed 1988).

OBL/Obligate Wetland - USFWS Indicator Status: Occur almost always in wetlands (estimated probability >99%) under natural conditions (Reed 1988).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point-frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point-Intercept Device – a tripod that supports a rod that can be leveled and lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point-quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which inferences are made.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance (birds) – the number of individuals per unit of sampling effort.

Relative cover – the relative cover of a plant species (or suite of species) is the proportion of the target species coverage compared to that of all species in the plant community combined (Brower et al. 1998).

Restricted random sampling method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives provide a complement to success standards and describe the desired level of precision for sampling. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than six meters (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified random sampling method – the population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic random sampling method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – for vegetation surveys, the transect is a line used to assist in the location sample units (point-lines, quadrats, line-segments or frames) across the monitoring study area.

Tree – a woody plant that at maturity is usually six meters (20 feet) or more in height and generally has a single trunk, unbranched for one meter or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

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